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THE MAMMALS OF DEVILS RIVER STATE NATURAL AREA, TEXAS

JOEL G. BRANT AND ROBERT C. DOWLER

Devils River State Natural Area (DRSNA) is located about 40 miles (68 km) north of Del Rio in Val Verde County, Texas. In 1988, approximately 20,000 acres (8,097 hectares) of land was purchased from the Finegan Ranch, which comprised about one third of the original Fawcett Ranch, to create DRSNA. This state natural area is situated around Dolan Creek and its associated side canyons, including East Canyon, Rough Spring Canyon, and Live Oak Canyon (Figs. 1 and 2). The Devils River composes the southwestern boundary of the area and is fed by several springs, most notably Dolan Springs, which add 22,000 gallons (83,600 L) of water per minute to the river (Smith, 1975). Annual precipitation in the area averages 18.81 inches (65.84 mm) however, during 1998 and 1999 DRSNA was experiencing a drought with the average annual rainfall of 13.51 inches (47.29 mm) recorded by the National Oceanic and Atmospheric Administration (NOAA) from the Del Rio International Airport (Bryan et al., 2001). Vertical relief in the park averages 200-300 feet (67-100 m), with slopes of 25-30 percent (Texas Parks and Wildlife Department, 1990).

Devils River State Natural Area is an ecotonal zone at the juncture of three ecogeographic regions: the Edwards Plateau to the north and east, the South Texas Plains to the south, and the Trans-Pecos to the west (Blair, 1950). This confluence of ecoregions creates an area where eastern species might reach the western extent of their range and southern species might attain their northern limits. The Devils River also creates a dispersal corridor for southern species to move northward into west-central Texas.

The soils of DRSNA (Fig. 3) are composed mainly of Ector-Rock associations, which are subdivided into two categories, hilly and very steep. The very steep category is the most abundant and occurs in association with canyon slopes throughout the park. The hilly subdivision is restricted to the plateau between the canyons. Other soil types including Olmos very gravelly loams, Dev soils, and Riverwash, occur along Dolan Creek and its tributaries in East Canyon and Speed Canyon (Golden et al., 1982).

The first reports of mammals in Val Verde County were included in Vernon Bailey's biological survey of Texas (1905). Bailey reported 82 species of mammals in the Lower Sonoran Zone that includes the Devils River Valley. The first comprehensive mammalian survey for eastern Val Verde County was performed by Boston (1966). He reported the occurrence of 39 species of mammals including county records for the desert shrew (*Notiosorex crawfordi*) and the hoary bat (*Lasiurus cinereus*), and sightings of the hooded skunk (*Mephitis macroura*) in Val Verde County. Scudday and Hanselka (1975) first surveyed the mammals of the Dolan Creek – Dolan Falls area, a good portion of which would later become DRSNA. They reported 39 species of mammals, 29 collected by them and 10 reported in the literature. The most recent study that included this area was the Mammals of the Edwards

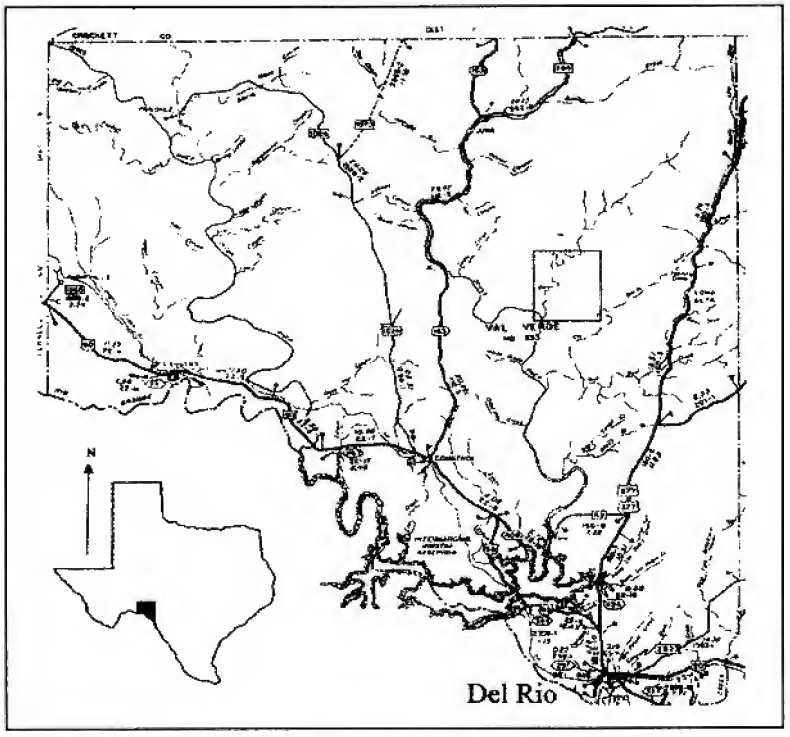

Figure 1. Location of Devils River State Natural Area in Val Verde County, Texas.

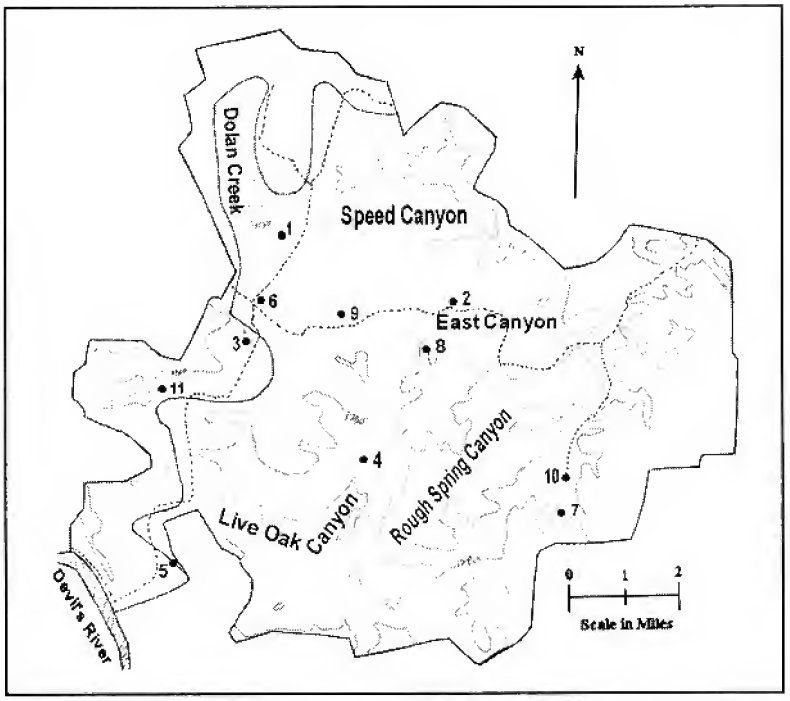

Figure 2. Devils River State Natural Area with primary sampling sites labeled. 1) Juniper Slope, 2) East Canyon Slope, 3) Cenizo Slope, 4) Grassland Plateau, 5) Dolan Springs, 6) the Headquarters Building, 7) Fawcett Cave, 8) Radio Towers, 9) First Landing Strip, 10) Second Landing Strip, 11) Jose Maria Springs.

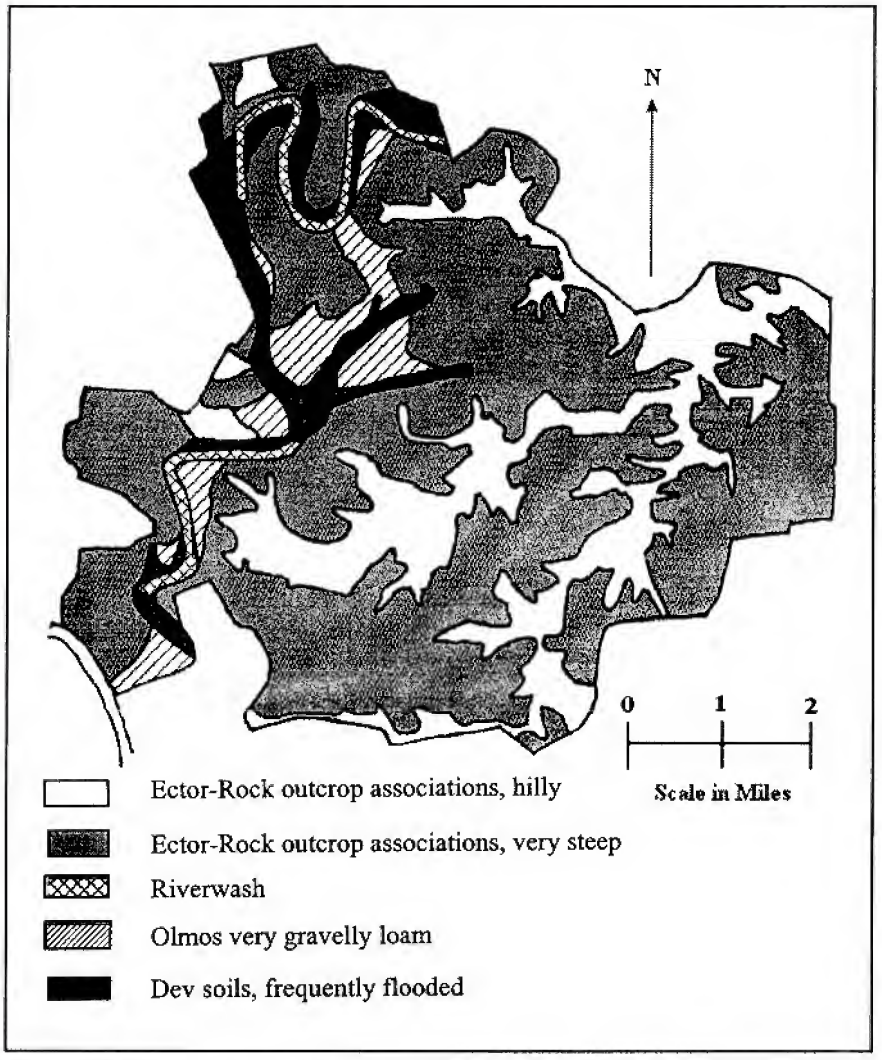

Figure 3. A soil map of Devils River State Natural Area, adapted from Golden et al. (1982).

Plateau, Texas (Goetze, 1998). Many of the species listed by Goetze (1998) should be expected to occur at Devils River State Natural Area.

The objectives of this study to describe the mammalian fauna of the Devils River State Natural Area are: 1) to determine the occurrence of mammal species, 2) to estimate the relative abundance of small rodent species, 3) to determine habitat associations for species, 4) to determine seasonal patterns of abundance for species, and 5) to report on seasonal reproductive patterns of species.

MATERIALS AND METHODS

The primary study sites at Devils River State Natural Area were selected on the basis of a report submitted to the Texas Parks and Wildlife Department (1990) on the vegetation of this area. That study designated 13 sites as representative of the vegetation communities. For this study of the mammalian fauna, five of those 13 sites were selected as representative of the habitat types in the park, as follows: Riparian, Juniper-

Oak Series shrubland, Cenizo Series shrubland, Lechuguilla-Sotol Series desert shrubland, and Curlymesquite-Sideoats Grama Series grassland. One primary sampling site was assigned to each habitat type and sampled seasonally. Primary sampling sites were used to gather data on reproductive status and relative abundance of rodents. The primary sampling sites (Fig. 2) are as follows: Juniper Slope, East Canyon, Cenizo Slope, Grassland Plateau, and Dolan Springs. Supplementary sampling was carried out in addition to the primary sites to gain a comprehensive list of mammals in the area without depleting the primary sample sites. Each sampling site was recorded using handheld global positioning system (GPS) receivers (Garmin 12xls) with readings in latitude and longitude.

The Juniper Slope site (29° 57.3' N, 100° 57.9' W) is a Juniper – Oak Series shrubland, the most common vegetation type encountered at Devils River State Natural Area (Fig. 4). The soil composition is gravelly colluvial loams with exposed bedrock near the top of the slope.

East Canyon (29° 56.6' N, 100° 56.1' W) is a south-facing slope that supports a xeric Lechuguilla – Sotol Series desert shrubland. The soil is composed of shallow clay loams between boulders and bedrock fractures. Exposed bedrock is common on this slope and creates striations across the slope. This slope was the steepest sampled at 33%.

Cenizo Slope (29° 55.9' N, 100° 58.5' W) is very similar to Juniper Slope but faces southeast and the vegetation is Cenizo Series shrubland with fewer junipers (Fig. 6). The soil is similar to Juniper Slope except that there is little or no exposed bedrock.

Grassland Plateau (29° 55.2' N, 100° 57.1' W) is a Curlymesquite – Sideoats Grama Series grassland, the least common vegetation type within DRSNA (Fig. 7). Grassland habitat is only found on ridge tops between canyons and only where the area is great enough for soils to accumulate. The soil composition is moderately shallow, stony loams with no bedrock exposed.

The primary sampling site at Dolan Springs (29° 53.8' N, 100° 59.1' W) is a riparian habitat of Netleaf Hackberry – Little Walnut Series deciduous woodland (Fig. 8). The soil composition is silty alluvial loams distal to the springs and limestone bedrock adjacent to the springs.

Standard techniques for sampling small to medium-sized species were utilized to survey the mammalian fauna (Jones et al., 1996: Animal Care and Use Committee, 1998). Sherman live traps were used for rodents, Tomahawk live traps for medium-sized species, mist nets for bats, and pitfall traps for shrews. Large mammals and other species that are difficult to trap were sampled using spotlighting, firearms, and sightings.

Voucher specimens were made for the first capture of a species on a primary sampling site each season. Other individuals of the same species captured during the same season on the same primary sampling site were identified in the field and released after measurements of tail length, hind foot length, and ear length were taken. These individuals were marked by cutting a line in the fur on the back and then released at the point of capture. Voucher specimens were prepared as museum study skins and skeletons and deposited in the Angelo State Natural History Collections (ASNHC). Frozen tissue samples for most specimens were also deposited in the Collection of Frozen Tissues, ASNHC.

Specimen records also were obtained from the following systematic collections: Angelo State Natural History Collections (ASNHC), University of California, Berkeley (MVZ), Vertebrate Collection, Sul Ross State University (SRSU), Texas Cooperative Wildlife Collection at Texas A&M University (TCWC), Museum of Texas Tech University (TTU), and National Museum of Natural History (USNM). Interviews were conducted with residents at DRSNA, Bill and Paula Armstrong and Jim Finegan, to determine the recent history of the area and establish species of mammals formerly occurring at DRSNA.

Relative abundance was estimated using capture indices (Conroy, 1996) based on the number of individual animals captured per unit of time and effort (e.g., trap-night, net-hour). Primary sites were sampled using 200 trap-nights per season, for a total of 800 trap-nights per primary sampling site.

Figure 4. Juniper Slope primary sampling site at Devils River State Natural Area.

Figure 5. East Canyon primary sampling site at Devils River State Natural Area.

Figure 6. Cenizo Slope primary sampling site at Devils River State Natural Area.

Figure 7. Grassland Plateau primary sampling site at Devils River State Natural Area.

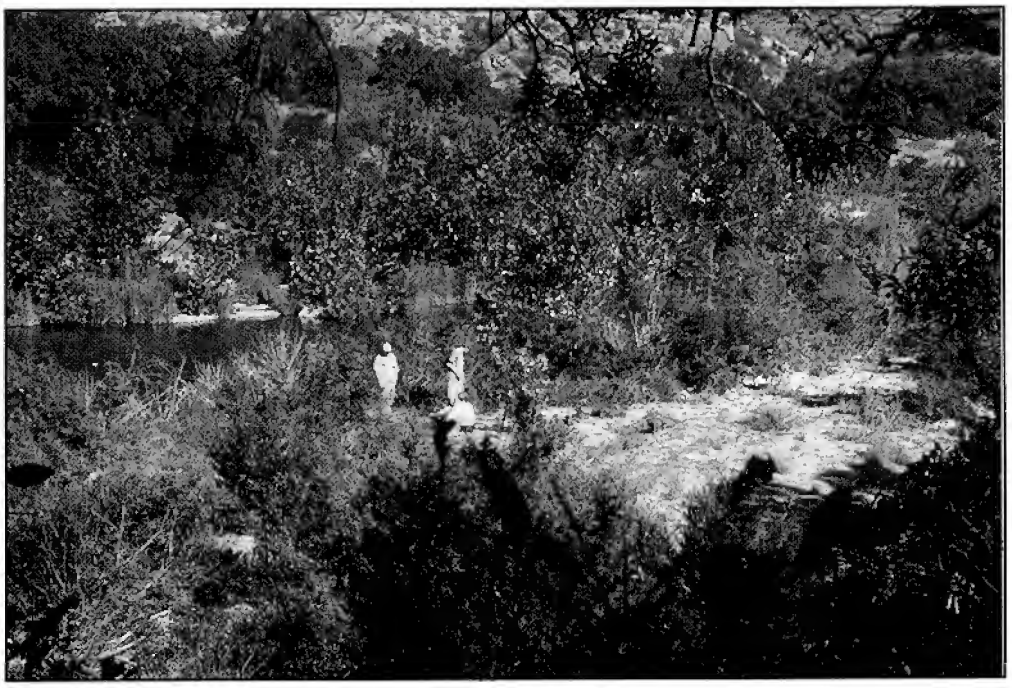

Figure 8. Dolan Springs primary sampling site at Devils River State Natural Area.

Capture indices were analyzed using a canonical correspondence analysis to determine the effect of habitat on the relative abundance of species within the park (ter Braak, 1986). Environmental variables measured were as follows: three vegetation variables (percent woody vegetation, percent succulent vegetation, and percent herbaceous vegetation), five soil variables (percent soil, percent gravel, percent cobblestone, percent boulder, percent bedrock), and slope. Measurement of these variables was performed using 50 m transects. For each transect the percentage of each variable was determined by the total distance (in meters) that the variable occurred divided by the total distance measured (50 m). Transects were surveyed seasonally starting in March 1999 and ending in November 1999. Each primary sampling site had transects for a minimum of two seasons.

SPECIES ACCOUNTS

This study records the presence of eight orders and 18 families of mammals at Devils River State Natural Area. The following accounts treat 39 species native to DRSNA including three county records. All collection localities are recorded in relation to the Headquarters Building (Fig. 2). Brant (2000) has maps showing locations of captures and sightings for each species.

The sequence of species accounts conforms to the phylogenetic order presented in Nowak (1999). Scientific names follow Wilson and Reeder (1993). All subspecific designations are according to Hall (1981). Common names follow Davis and Schmidly (1994).

ORDER DIDELPHIMORPHIA
Family Didelphidae

Didelphis virginiana californica Bennett, 1833 (Virginia Opossum): The opossum occurs in riparian areas of DRSNA but no specimens were collected during this study. Their absence could be a result of the drought this area has been experiencing for the

past several years or a result of the flood that occurred in August 1998. Bill Armstrong, DRSNA manager, reported that few opossums are encountered in the area and that he has only seen four individuals since 1988 (pers. comm.). Scudday and Hanselka (1975) reported that the opossum is fairly common east of the Pecos River and may be encountered in any part of the area.

Although no opossums were collected during this study, one individual was sighted crossing the creek bed of Dolan Creek two miles north and one mile east of the Headquarters Building on 30 October 1999. Two specimens in the Angelo State Natural History Collections were previously collected from Jose Maria Springs and Dolan Springs on 24 October 1993.

Specimens examined (2): Jose Maria Springs, 1 (ASNHC 9610); Dolan Springs, 1 (ASNHC 10973).

ORDER XENARTHRA
Family Dasypodidae

Dasypus novemcinctus mexicanus Peters, 1864 (Nine-banded Armadillo): Scudday and Hanselka (1975) reported that the armadillo could be found anywhere in the area but seemed to prefer riparian habitats. Two specimens were collected during this study and individuals were sighted throughout the area in all seasons. Juveniles were seen during August and September at two locations. One male was collected in the Dolan Creek wash on 6 July 1998 and one female was collected near the Devils River on 10 September 1999.

Specimens examined (2): ¼ mi. S Headquarters Building (in Dolan Creek bottom), 1 (ASNHC 10651); 3 mi. S, 1 ½ mi. W Headquarters Building, along the Devils River (29° 53.7' N, 100° 59.7'W), 1 (ASNHC 10974).

ORDER INSECTIVORA
Family Soricidae

Notiosorex crawfordi crawfordi (Coues, 1877) (Desert Shrew): Boston (1966) reported the first specimen of the desert shrew for Val Verde County. Since then only one other specimen (SRSU 3009) has been collected from the county. Scudday and Hanselka (1975) listed this species as possible for the area but unrecorded.

Four specimens were collected during this study. Two were collected on a slope above the Plateau Live Oak grove next to Dolan Springs. One of these was hand caught on 15 June 1998, after it was discovered under a rock. The other was a skeleton found in a natural pitfall on 17 June 1998. Two more specimens were collected (on 8 May 1999 and 30 October 1999) in pitfall traps on the north side of DRSNA. None of the specimens collected during this study were reproductively active.

Specimens examined (4): 2¼ mi. N Headquarters Building (29° 58.4' N, 100° 58.2' W), 2 (ASNHC 10652-10653); 3 mi. S, 1 mi. W Headquarters Building (29° 53.8' N, 100° 59.1' W), 2 (ASNHC 10656-10657).

ORDER CHIROPTERA
Family Vespertilionidae

Myotis velifer incautus (J. A. Allen, 1896) (Cave Myotis): The cave myotis is the only species of myotis known to occur at DRSNA. Fawcett Cave in the southeastern corner of DRSNA (Fig. 2) supports a large colony during summer months and is possibly a hibernation site for this and other species of bats. Bat flights were witnessed from May to November with several hundred bats emerging from the cave. Emergence began just after dark and had durations of two hours. Sampling at this site was accomplished using a standard hoop-net used for collecting insects. The cave mouth is only about three feet in diameter and descends about 30 to 40 feet. The last bat flight witnessed was on 1 November 1999 with an emergence of about 100 bats. On 14 November 1999 several bats were observed in flight inside the cave but none emerged. On 20 November 1999 no bat activity was observed. Deal and Fieseler (1975) mapped Fawcett Cave and showed the location of the bat colony on a detailed map. *Myotis velifer* is the only species listed as inhabiting this cave.

Eleven specimens were collected at three sites in DRSNA. Four specimens were collected from Fawcett Cave, two males and two females, in July 1999. Four specimens were collected at Dolan Springs in mist nets set across the springs. A male and female

were collected in June 1998 and a female and scrotal male were collected in September 1999. Three males were collected from Jose Maria Springs on 23 October 1993.

Specimens examined (11): 1 mi. S, 1 mi. W Headquarters Building, Jose Maria Springs, 3 (ASNHC 10663-10665); 2 mi. S, 3 ½ mi. E Headquarters Building, Fawcett Cave (29° 54.6' N, 100° 54.7' W), 4 (ASNHC 10666-10669); 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 4 (ASNHC 10670-10672, 10981).

Additional records: Dolan Springs, Fawcett Ranch, 5 (SRSU 1508, 1510-1512, 1514); Dolan Springs, 36 mi. N, 6 mi. W Del Rio, 2 (TTU 6166-6167); Fawcett Cave 36 mi. N Del Rio, 10 (TTU 6579-6581, 7240-7246).

Pipistrellus hesperus maximus Hatfield, 1936 (Western Pipistrelle): At DRSNA seven specimens of western pipistrelle from two localities were collected. Two females were collected on 17 June 1998 from a pool near Jose Maria Springs. Two males and one female were collected from Dolan Springs on 7 July 1998 and one male was collected from the same site on 17 April 1999. Another specimen was collected from Dolan Springs on 23 June 1998. One female collected from a pool near Jose Maria Springs on 16 April 1999 had two embryos with crown-rump lengths of 7 mm.

Specimens examined (7): 1 mi. S, 1 mi. W Headquarters Building, pool near Jose Maria Springs (29° 55.6' N, 100° 59.3' W), 2 (ASNHC 10673-10674); 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 5 (ASNHC 10675-10678, 10975).

Additional records: Dolan Springs, Fawcett Ranch, 2 (SRSU 1505, 1513); Dolan Falls, Fawcett Ranch, 2 (SRSU 1998, 2002).

Nycticeius humeralis mexicanus Davis, 1944 (Evening Bat): The evening bat ranges throughout eastern and southern Texas reaching the western extent of its range in the Hill Country region of Texas. Recent records of the evening bat suggest that it has been expanding the western limits of its range into the Trans-Pecos and west-central Texas (Manning et al., 1987; Dowler et al., 1992; Dowler et al., 1999). This species is mainly associated with woodland vegetation around or near streams or rivers (Schmidly, 1991).

One specimen of the evening bat was collected at DRSNA. Dowler et al. (1999) reported the collection of a male at Jose Maria Springs on 7 July 1998. This specimen is a county record and a range extension of about 50 miles (80 km) from the nearest known records in Kinney County, Texas.

Specimens examined (1): 1 mi. S, 1 mi. W Headquarters Building, Jose Maria Springs (ASNHC 10105).

Lasiurus cinereus cinereus (Palisot de Beauvois, 1796) (Hoary Bat): The hoary bat is a migratory species distributed across the state but few records exist for Val Verde County or the Edwards Plateau (Goetze, 1998). In Val Verde County one individual was collected in Del Rio near the Rio Grande River (Boston, 1966).

Three specimens of the hoary bat were collected at DRSNA. All were collected in mist nets over Dolan Springs. One female was collected on 8 May 1999. One male with testes measuring 7 by 5 mm and one female were collected within minutes of each other on 12 September 1999. These specimens represent the 2nd - 4th specimens recorded in Val Verde County. Although they did not collect any specimens, Scudday and Hanselka (1975) reported seeing this species at DRSNA.

Specimens examined (3): 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 3 (ASNHC 10660-10662).

Lasiurus seminolus (Rhoads, 1895) (Seminole Bat): The Seminole bat is an eastern species that reaches the limits of its range in east Texas. Recently it has expanded its range to include Burleson County (Lee, 1987), Fayette County (Yancey and Jones, 1996), and Travis County (Brant and Dowler, 2000). This species is often found in association with Spanish moss (*Tillandsia usneoides*) and prefers forested areas. They can also be found roosting singly behind loose tree bark or under foliage (Schmidly, 1991).

One specimen was collected at DRSNA. A female that was not reproductively active was taken at Dolan Springs on 10 September 1999. This specimen represents the westernmost record for this species occurring 200 miles (320 km) from the nearest known record for the Seminole bat. This is an important record for a species that was not expected to occur in Val Verde County, Texas. Brant and Dowler (2000) discuss the possible explanations for the occurrence of this eastern forest species in a western arid environment.

Specimens examined (1): 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 1 (ASNHC 10650).

Antrozous pallidus pallidus (Le Conte, 1856) (Pallid Bat): This species reaches its eastern distributional limits in Texas in the Edwards Plateau where records are sparse (Goetze, 1998). Three specimens were collected from DRSNA. A male and a female were netted at a pool near Jose Maria Springs on 10 September 1999. The male was scrotal with testes measuring 12 by 4 mm. A male was also collected from Dolan Springs on 17 April 1999.

Specimens examined (3): 1 mi. S, 1 mi. W Headquarters Building, pool near Jose Maria Springs (29° 55.6' N, 100° 59.3' W), 2 (ASNHC 10658, 10976); 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 1 (ASNHC 10659).

Additional records: Dolan Falls, Fawcett Ranch, 1 (SRSU 2001); Dolan Falls, 0.5 mi. NW camp house, 1 (SRSU 1997); Dolan Springs, Fawcett Ranch, 2 (SRSU 1506-1507).

Family Molossidae

Tadarida brasiliensis mexicana (Saussure, 1860) (Brazilian Free-tailed Bat): This common bat in Texas has roosts in buildings associated with the DRSNA manager's residence. None were collected with emerging bats at Fawcett Cave. *Tadarida brasiliensis* are usually found in caves with domed ceilings, a minimum height of 10 m, and an entrance size of 5 by 10 m (Wilkins, 1989), which could explain their absence from Fawcett Cave.

Seventeen specimens of *T. brasiliensis* were collected from DRSNA. Six specimens were collected from a pool near Jose Maria Springs on two occasions, five males on 10 September 1999 and one female on 16 April 1999. Ten specimens were collected from Dolan Springs on six occasions in the months of April, June, August, and September. No reproductively active individuals were recorded.

Specimens examined (17): 1 mi. S, 1 mi. W Headquarters Building, pool near Jose Maria Springs (29° 55.6' N, 100° 59.3' W), 6 (ASNHC 10679-10683, 10977); 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 10 (ASNHC 10684-10690, 10978-10980); Dolan Creek and Devils River, 1 (ASNHC 7606).

Additional records: Dolan Falls, Fawcett Ranch, 2 (SRSU 1999-2000); Dolan Springs, Fawcett Ranch, 2 (SRSU 1509, 1519).

ORDER CARNIVORA
Family Canidae

Urocyon cinereoargenteus scottii Mearns, 1891 (Common Gray Fox): At DRSNA gray foxes were encountered on rocky slopes containing juniper-oak series vegetation, in rocky washes, and occasionally along the ridge tops. Three specimens of *U. cinereoargenteus* were collected at DRSNA. Two skulls were collected on different occasions from Jose Maria Springs and along the Devils River. A female that was not reproductively active was collected in a Tomahawk live trap at the Juniper Slope primary sampling site on 7 July 1998. Several other gray foxes were sighted in the washes of Dolan Creek and along the canyon rims.

Specimens examined (3): 1 mi. N, ¼ mi. E Headquarters Building, Juniper Slope (29° 57.3' N, 100° 57.9' W), 1 (ASNHC 11139); 1 mi. S, 1 mi. W Headquarters Building, Jose Maria Springs, 1 (ASNHC 10315); 3 mi. S, 1 ½ mi. W Headquarters Building, Devils River (29° 53.7' N, 100° 59.7' W), 1 (ASNHC 10982).

Family Procyonidae

Bassariscus astutus flavus Rhoads, 1894 (Ringtail): Two specimens of the ringtail were collected at DRSNA. A nonscrotal male was collected on 7 January 1999 at the East Canyon primary sampling site. A female without embryos was collected on 13 January 1999 at the Juniper Slope primary sampling site. Another individual was sighted on the cliffs along the Devils River in September 1999. Paula Armstrong reported seeing a ringtail on the equipment barn near the DRSNA headquarters in June 2000 (pers. comm.).

Specimens examined (2): 1 mi. N, ¼ mi. E Headquarters Building, Juniper Slope (29° 57.3' N, 100° 57.9' W), 1 (ASNHC 10692); ¼ mi. N, 2 ¼ mi. E Headquarters Building, East Canyon (29° 56.6' N, 100° 56.1' W), 1 (ASNHC 10693).

Procyon lotor fuscipes Mearns, 1914 (Common Raccoon): Raccoons were among the most common carnivores at DRSNA and were collected in all habitat types. Six specimens of *P. lotor* were collected at DRSNA. Two specimens were collected from Dolan Springs on separate occasions, 7 August 1998 and 13 January 1999. One female was collected from Dolan Creek in the northern portion of DRSNA on 28 March 1999. Two specimens were collected during May 1999, one male from the Juniper Slope primary sampling site on the 9th and an individual from the southern ridge above East Canyon on the 20th. A male was collected along the Dolan Creek Road just past campsite four on 12 September 1999. Many other individuals were sighted or captured then released throughout DRSNA. Two scrotal males were recorded in August 1998 and September 1999 with testes measurements of 23 by 15 mm and 30 by 26 mm respectively. No reproductively active females were recorded during this study.

Specimens examined (6): 2 ¼ mi. N Headquarters Building (29° 58.4' N, 100° 58.2' W), 1 (ASNHC 11142); 1 mi. N, ¼ mi. E Headquarters Building, Juniper Slope (29° 57.3' N, 100° 57.9' W), 1 (ASNHC 10694); ¼ mi. S, 3 ½ mi. E Headquarters Building, 1 (ASNHC 10301); 1 ½ mi. S, ¾ mi. W Headquarters Building, 1 (ASNHC 11143); 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 2 (ASNHC 10695, 11144).

Additional records: Dolan Springs, 36 mi. N, 6 mi. W Del Rio, 1 (TTU 6665).

Family Mustelidae

Taxidea taxus berlandieri Baird, 1858 (American Badger): *Taxidea taxus* ranges throughout Texas except in eastern portions of the state. It is most commonly associated with open habitats such as grasslands and deserts. Because badgers may avoid areas with shallow, stony soils (Goetze, 1998), the lack of habitat or deep soil at DRSNA make the probability of encountering this species low.

No specimens of the badger were collected at DRSNA but one individual was sighted in the area on 29 July 1999 at about 2300 hrs. This individual was seen along the East Canyon Road as it ascends to the canyon rim. Occasionally, Bill Armstrong will find a badger hole on the property, but has never seen an individual (pers. comm.). Jim Finegan, who was raised in the area, has only seen two badgers in the area (pers.comm.). Lindzey (1982) suggested that young dispersing badgers often cross areas of habitat that seem unfavorable, which might account for the occurrence of *T. taxus* in DRSNA.

Family Mephitidae

Spilogale gracilis leucoparia Merriam, 1890 (Western Spotted Skunk): The rocky slopes, washes, and canyons of DRSNA provide ample habitat for this species, which usually occurs in rocky areas in the Edwards Plateau (Goetze, 1998). One female *S. gracilis* was collected at DRSNA on 30 October 1999 at the Cenizo Slope primary sampling site. This specimen represents the 4th record for this species in Val Verde County. The nearest records are one specimen from Comstock collected in 1890 and two specimens from Langtry collected in 1903 (Bailey, 1905). Boston (1966) reported seeing one near Sycamore Creek in southeastern Val Verde County.

Specimens examined (1): ½ mi. S Headquarters Building, Cenizo Slope (29° 55.9' N, 100° 58.5' W), 1 (ASNHC 11141).

Mephitis mephitis varians Gray, 1837 (Striped Skunk): *Mephitis mephitis* was found in all habitats at

DRSNA. Four specimens of the striped skunk were collected from DRSNA. A male was collected on 22 October 1993 in the area. Two males were collected from near the Headquarters Building, one on 14 January 1999 and the other on 21 November 1999. A female was collected in the Grassland Plateau primary sampling site on 14 November 1999. Three other individuals were sighted along Dolan Creek.

Specimens examined (4): Headquarters Building (29° 56.4' N, 100° 58.3' W), 2 (ASNHC 11140, 11165); 1 1/3 mi. S, 1 mi. E Headquarters Building, Grassland Plateau (29° 55.2' N, 100° 57.1' W), 1 (ASNHC 10691); Devils River State Natural Area, 1 (ASNHC 11166).

Conepatus mesoleucus mearnsi Merriam, 1902 (Common Hog-nosed Skunk): Two specimens of *C. mesoleucus* were collected in DRSNA. A male was collected two miles south and one mile west of the Headquarters Building on 10 September 1999. A male was collected along the East Canyon Road in the East Canyon primary sampling site on 19 November 1999. Other individuals were sighted at the Grassland Plateau primary sampling site and near the airstrip in the southeastern corner of the area. Paula Armstrong has seen only one individual near her house in the last ten years (pers. comm.).

Specimens examined (2): ¼ mi. N, 2¼ mi. E Headquarters Building, East Canyon (29° 56.6' N, 100° 56.1' W), 1 (ASNHC 11163); 2 mi. S, 1 mi. W Headquarters Building (29° 54.6' N, 100° 59.4' W), 1 (ASNHC 11164).

Family Felidae

Lynx rufus texensis J. A. Allen, 1895 (Bobcat): No specimens of *L. rufus* were collected at DRSNA. Two individuals were sighted at different locations in the park and bobcat sign, such as feces and tracks, were found near Dolan Springs. Bill Armstrong reported repeatedly sighting a female with two young along a ridge two miles north and one mile east of the Headquarters Building. In December 1999, he saw a bobcat along East Canyon Road (pers. comm.).

Puma concolor stanleyana (Goldman, 1936) (Mountain Lion): No specimens of *P. concolor* were collected at DRSNA. Scudday and Hanselka (1975) listed this species as occasionally passing through the area. On 15 June 1992, a female *P. concolor* (ASNHC 9658) was collected from the Russell Ranch near Loma Alta, to the east of DRSNA. Hunters sighted an individual on the plateau between East Canyon and Rough Spring Canyon in November 1998. In July 1999 a felid scream was heard by J. G. Brant at about 2200 hrs. in the direction of the south rim of East Canyon. This scream seemed to be too deep for *L. rufus* but the identity of the source was not confirmed. Some visitors to DRSNA reported seeing a mountain lion next to the Bunk House in September 1999 (Bill Armstrong, pers. comm.).

ORDER ARTIODACTYLA

Family Tayassuidae

Pecari tajacu angulatus (Cope, 1889) (Collared Peccary): Three specimens of *P. tajacu* were collected from DRSNA. Two were skulls found at Dolan Springs, one on 27 March 1999 and one on 19 November 1999. Several individuals were sighted at Dolan Springs and a herd of about 15 individuals with three young was sighted crossing Dolan Creek Road two miles south and one mile west of the Headquarters Building in November 1999. Bill Armstrong reported that collared peccaries were abundant in 1988 with sightings concentrated around Dolan Creek. In the last four years he has not seen them and believes they are decreasing in abundance (pers. comm.). According to Jim Finegan the population seemed to crash around 1989 or 1990. He only knows of two current groups, one in Oliver Canyon and one near Jose Maria Springs (pers. comm.).

Specimens examined (3): 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 2 (ASNHC 10696, 10983); Devils River State Natural Area, 1 (ASNHC 9664).

Family Cervidae

Odocoileus virginianus texanus (Mearns, 1898) (White-tailed Deer): No specimens of white-tailed deer were collected from DRSNA, but they were sighted in every habitat type. Annual deer hunts are a source of income for the property with two gun hunts and one bow hunt sold each year. About seven or eight white-tailed deer are harvested annually from the combined hunts (Bill Armstrong, pers.comm.).

ORDER RODENTIA

Family Sciuridae

Ammospermophilus interpres (Merriam, 1890) (Texas Antelope Squirrel): No specimens of *A. interpres* were collected from DRSNA. Several individuals were sighted in East Canyon and in Dolan Creek north of the Headquarters Building in November 1998 and in the spring of 1999.

Spermophilus mexicanus parvidens Mearns, 1896 (Mexican Ground Squirrel): One female *S. mexicanus* was collected from DRSNA on 7 July 1998 while crossing the Dolan Creek Road. No other individuals were sighted in DRSNA but one was sighted in May 1999 just outside the area on private land.

Specimens examined (1): 1 mi. S. Headquarters Building (ASNHC 10697).

Spermophilus variegatus grammurus (Say, 1823) (Rock Squirrel): In DRSNA rock squirrels are usually found in association with rocky slopes. Two specimens of *S. variegatus* were collected from DRSNA. One female was collected on 14 November 1998 and another female was collected from a different locality on 15 November 1998. One individual was sighted at the base of the East Canyon primary sampling site on 20 November 1999 and another individual was seen near the radio towers on the southern rim of East Canyon. Paula Armstrong reported seeing a rock squirrel near campsite six (pers. comm.).

Specimens examined (2): 2 ¼ mi. N Headquarters Building (29° 58.4' N, 100° 58.2' W), 1 (ASNHC 11146); ¾ mi. SW Headquarters Building, 1 (ASNHC 10698).

Additional records: Dolan Falls, 1 mi. W Dolan Falls, 1 (SRSU 1537).

Sciurus niger limitis Baird, 1855 (Eastern Fox Squirrel): No specimens of fox squirrels were collected from DRSNA. One individual was sighted at Jose Maria Springs during the summer of 1998 and another individual was seen along the Devils River in June 1999. Bill Armstrong reported eastern fox squirrels inhabiting the oak grove near Dolan Springs (pers. comm.).

Additional records: 36 mi. N, 6 mi. W Del Rio, 1 (TTU 6671).

Family Castoridae

Castor canadensis mexicanus V. Bailey, 1913 (American Beaver): No specimens of the beaver were collected from DRSNA. Scudday and Hanselka (1975) do not list this species as occurring in the area but state that beavers occasionally occur in Dolan Creek and disappear after a major flood. Boston (1966) listed this species as occurring throughout Val Verde County in every major river and stream. The nearest record for *C. canadensis* is about 5 miles north of Del Rio on the Devils River. A stump that possibly could have been cut down by a beaver was found near Dolan Springs in June 1998. According to Bill Armstrong (pers. comm.), beavers were fairly prolific in DRSNA as recently as 1996. Beaver Lake is further upstream on the Devils River near the town of Juno. This implies that beaver were common in this stretch of the Devils River.

Family Heteromyidae

Perognathus merriami gilvus Osgood, 1900 (Merriam's Pocket Mouse): At DRSNA this species was most commonly found in relatively loose, gravelly soil. Eleven specimens of *P. merriami* were collected from DRSNA. Two specimens were collected from the Grassland Plateau primary sampling site on 7 January 1999 and 19 August 1999. One specimen was collected from the Juniper Slope primary sampling site on 9 May 1999. One specimen was collected at the Headquarters Building on 12 September 1999. Seven specimens were collected in funnel traps set in association with drift fences for a reptile survey from an area 2¼ miles north of the Headquarters Building on several occasions.

Specimens examined (11): 2 ¼ mi. N Headquarters Building (29° 58.4' N, 100° 58.2' W), 7 (ASNHC 10720-10721, 11004-11008); 1 mi. N, ¼ mi. E Headquarters Building, Juniper Slope (29° 57.3' N, 100° 57.9' W), 1 (ASNHC 11009); Headquarters Building (29° 56.4' N, 100° 58.3' W), 1 (ASNHC 11010); 1 1/3 mi. S, 1 mi. E Headquarters Building, Grassland Plateau (29° 55.2' N, 100° 57.1' W), 2 (ASNHC 10721, 11011).

Chaetodipus nelsoni canescens (Merriam, 1894) (Nelson's Pocket Mouse): At DRSNA this species is encountered in slope habitats. This species was the second most frequently encountered rodent at DRSNA with 41 specimens collected from the area. *Chaetodipus nelsoni* was the second most abundant rodent at each primary sampling site with the exception of Grassland Plateau, where it was not encountered. Specimens were collected in every season with this species being the most abundant summer rodent at DRSNA. Scudday and Hanselka (1975) listed this species as possibly occurring in the area but unverified. Reproductive individuals were recorded from January to July with three scrotal males collected from January to June and six reproductive females collected from June to July.

Specimens examined (41): 1 mi. N, ¼ mi. E Headquarters Building, Juniper Slope (29° 57.3' N, 100° 57.9' W), 4 (ASNHC 10699-10700, 10984-10985); ¼ mi. N, 2¼ mi. E Headquarters Building, East Canyon (29° 56.6' N, 100° 56.1' W), 3 (ASNHC 10701, 10986-10987); ½ mi. S Headquarters Building, Cenizo Slope (29° 55.9' N, 100° 58.5' W), 3 (ASNHC 10704, 10988-10989); 1 mi. S Headquarters Building, 6 (ASNHC 10702-10703, 10707-10708, 10717, 10990); 1 mi. S, 1 mi. W Headquarters Building, Jose Maria Springs (29° 55.6' N, 100° 59.3' W), 3 (ASNHC 10705-10706, 11003); 2¼ mi. S, 1½ mi. W Headquarters Building, 3 (ASNHC 10709-10710, 10991); 3 mi. S, 1 mi. W Headquarters Building, Oak Grove Campground, 6 (ASNHC 10992-10997); 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 11 (ASNHC 10711-10716, 10998-11002); Devils River State Natural Area, 2 (ASNHC 10718-10719).

Additional records: 36 mi. N, 6 mi. W Del Rio, 1 (Jones and Manning, 1991).

Family Muridae

Neotoma albigula albigula Hartley, 1894 (White-throated Woodrat): Only one specimen of the white-throated woodrat was recorded from DRSNA during this study. A subadult female was collected on Dolan Creek Road on the night of 11 September 1999. Scudday and Hanselka (1975) list this species as probably occurring in the area but unverified.

Specimens examined (1): 2½ mi. S Headquarters Building (ASNHC 11147).

Additional records: 36 mi. N, 6 mi. W Del Rio, 1 (TTU 6909).

Peromyscus maniculatus blandus Osgood, 1904 (Deer Mouse): Six specimens of the deer mouse were collected from DRSNA. One male was collected from Jose Maria Springs on 18 April 1999. Three specimens were collected at Dolan Springs, one female in June 1998 and two scrotal males in November and January 1999. The county record for this species was collected by Boston (1966) at several localities in Val Verde County including near Loma Alta.

Specimens examined (6): 2 ¼ mi. N Headquarters Building (29° 58.4' N, 100° 58.2' W), 1 (ASNHC 11015); 2 mi. N Headquarters Building (29° 58.3' N, 100° 58.2' W), 1 (ASNHC 11013); 1 mi. S, 1 mi. W Headquarters Building, Jose Maria Springs (29° 55.6' N, 100° 59.3' W), 1 (ASNHC 11014); 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 3 (ASNHC 10730-10731, 10780).

Peromyscus leucopus texanus (Woodhouse, 1853) (White-footed Mouse): Twelve specimens of the white-footed mouse were collected from DRSNA. One individual was collected from the Grassland Plateau on 7 January 1999. One male was collected from the Cenizo Slope primary sampling site on 23 June 1998. Ten specimens were collected from Dolan Springs on the limestone bedrock near brush. Six scrotal males with testes measuring larger than 11 by 8 mm were collected from August to January. Two pregnant females both with four embryos were recorded in August and November. Scudday and Hanselka (1975) listed this species as possibly occurring in the area but unverified.

Specimens examined (12): ½ mi. S Headquarters Building, Cenizo Slope (29° 55.9' N, 100° 58.5' W), 1 (ASNHC 10769); 1 1/3 mi. S, 1 mi. E Headquarters Building (29° 55.2' N, 100° 57.1' W), 1 (ASNHC 10778); 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 10 (ASNHC 10723-10729, 11012, 11017, 11149).

Peromyscus pectoralis lacianus V. Bailey, 1906 (White-ankled Mouse): The white-ankled mouse was the most commonly encountered rodent at DRSNA with 80 specimens collected from the area. It was the most abundant rodent at every primary sampling site except for Dolan Springs where it was third in abundance. *Peromyscus pectoralis* were collected in every season with this species being the most abundant rodent in autumn, winter, and spring. These findings are in agreement with Scudday and Hanselka (1975). Twenty-one scrotal males with testes measuring larger than 11 by 7 mm were recorded from October to March. Three females with an average of four embryos and two females with placental scars were recorded from January to March. Non-reproductive individuals were recorded from November to June.

Specimens examined (80): 2¼ mi. N, ¾ mi. E Headquarters Building (29° 58.4' N, 100° 56.9' W), 7 (ASNHC 10732-10736, 11020, 11150); 1 mi. N, ¼ mi. E Headquarters Building, Juniper Slope (29° 57.3' N, 100° 57.9' W), 10 (ASNHC 10737-10742, 11025-11027, 11151); ¼ mi. N, 2¼ mi. E Headquarters Building, East Canyon (29° 56.6' N, 100° 56.1' W), 17 (ASNHC 10743-10754, 10771, 11019, 11030, 11152-11153); ¼ mi. N, 1¼ mi. E Headquarters Building, Vegetation Site 9, 2 (ASNHC 11040-11041); ¼ mi. N, ¾ mi. E Headquarters Building, Airstrip (29° 56.7' N, 100° 57.4' W), 1 (ASNHC 11018); ½ mi. S Headquarters Building, Cenizo Slope (29° 55.9' N, 100° 58.5' W), 20 (ASNHC 10755-10769, 10770, 11031-11032, 11154); 1 mi. S, ½ mi. W Headquarters Building, Vegetation Site 1, 2 (ASNHC 11038-11039); 1mi. S, ½ mi. W Headquarters Building, Vegetation Site 12, 5 (ASNHC 11033-11037); 1 mi. S, 1 mi. W Headquarters Building, Jose Maria Springs (29° 55.6' N, 100° 59.3' W), 3 (ASNHC 11021, 11024); 1¼ mi. S, 1¾ mi. E Headquarters Building, Campsite A, 2 (ASNHC 10777-10778); 1 1/3 mi. S, 1 mi. E Headquarters Building, Grassland Plateau (29° 55.2' N, 100° 57.1' W), 7 (ASNHC 10772-10776, 11155-11156); 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 4 (ASNHC 10779, 11028-11029, 11157); Devils River State Natural Area, 2 (ASNHC 10781-10782).

Additional records: 36 mi. N, 6 mi. W Del Rio, 1 (TTU 6916); Dolan Creek, Along Dolan Creek, 2 (SRSU 1861-1862); Dolan Falls, Fawcett Ranch, 1 (SRSU 1889); Dolan Springs, 4 (SRSU 1515-1518).

Reithrodontomys montanus griseus V. Bailey, 1905 (Plains Harvest Mouse): One specimen of the plains harvest mouse was collected at DRSNA. A nonscrotal male was collected from the Grassland Plateau primary sampling site on 7 January 1999. The grassland habitat type is the only suitable habitat at DRSNA in which this species would be expected. This specimen represents the county record for *R. montanus* in Val Verde County, Texas, and is a range extension of more than 20 miles (>32 km) from the nearest record in Edwards County, Texas.

Specimens examined (1): 1 1/3 mi. S, 1 mi. E Headquarters Building, Grassland Plateau (29° 55.2' N, 100° 57.1' W), 1 (ASNHC 10784).

Reithrodontomys fulvescens lacyei J. A. Allen, 1896 (Fulvous Harvest Mouse): One nonscrotal male *R. fulvescens* was collected at Dolan Springs on 20 November 1999. This specimen was caught in a Sherman live trap that was set in a bush about 50 cm off the ground. This species was not listed in Scudday and Hanselka (1975) as expected in the area. The only other known records of this species in Val Verde County are two specimens (USNM 18355, 18358) collected in February 1890 from Del Rio (Bailey, 1905).

Specimens examined (1): 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 1 (ASNHC 10783).

Sigmodon hispidus berlandieri Baird, 1855 (Hispid Cotton Rat): Five specimens of *S. hispidus* were collected from DRSNA, all from a single locality. Three males and two females were collected from Dolan Springs over four separate occasions, 8 August 1998, 13 January 1999, 25 May 1999, and 20 November 1999. One scrotal male and one female with five embryos were recorded during August.

Specimens examined (5): 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 5 (ASNHC 10785-10789).

Family Erethizontidae

Erethizon dorsatum couesi Mearns, 1897 (Porcupine): Two specimens of *E. dorsatum* were collected from DRSNA. One road kill was collected from 1¼ mile north of the Headquarters Building on the Dolan Creek Road in June 1998. Another individual was trapped at the Juniper Slope primary sampling site on 12 January 1999. Other porcupines were sighted in the area, mostly around Dolan Creek. This species has been increasing in abundance since it was first sighted on the property by Jim Finegan and his grandfather around 1964 (pers.comm.).

Specimens examined (2): 1½ mi. N Headquarters Building, by road, 1 (ASNHC 10790); 1 mi. N, ¼ mi. E Headquarters Building, Juniper Slope (29° 57.3' N, 100° 57.9' W), 1 (ASNHC 11044).

ORDER LAGOMORPHA
Family Leporidae

Sylvilagus floridanus chapmani (J. A. Allen, 1899) (Eastern Cottontail): Twelve specimens of *S. floridanus* were collected at DRSNA. A male and a pregnant female with two embryos (crown-rump length of 60mm) were collected from Jose Maria Springs on 6-7 July 1998. A scrotal male with testes measuring 54 by 14 mm was collected from ¼ mile south and three miles east of the Headquarters Building on 19 November 1999. A female was collected from the Cenizo Slope primary sampling site on 8 August 1999 and a scrotal male was collected from that site on 14 November 1998. A scrotal male was collected from the Grassland Plateau primary sampling site on 13 January 1999.

Specimens examined (12): ½ mi. S Headquarters Building, Cenizo Slope (29° 55.9' N, 100° 58.5' W), 5 (10314, 10793, 11050-11051, 11064); ½ mi. S, 3 ¾ mi. E Headquarters Building (29° 53.8' N, 100° 54.1' W), 3 (ASNHC 10795, 11052, 11063); 1 mi. S, 1 mi. W Headquarters Building, Jose Maria Springs (29° 55.6' N, 100° 59.3' W), 1 (ASNHC 10792); 1 1/3 mi. S, 1 mi. E Headquarters Building, Grassland Plateau (29° 55.2' N, 100° 57.1' W), 1 (ASNHC 10794); 1 ½ mi. S, ¾ mi. W Headquarters Building, Campsite 2 (29° 55.5' N, 100° 59.1' W), 1 (ASNHC 11053); 3 mi. S, 1 mi. W Headquarters Building, Dolan Springs (29° 53.8' N, 100° 59.1' W), 1 (ASNHC 11062).

Sylvilagus audubonii parvulus (J. A. Allen, 1904) (Desert Cottontail): One desert cottontail was collected from DRSNA. A subadult male was collected from Jose Maria Springs on 7 July 1998. Scudday and Hanselka (1975) reported this species as occurring in the Dolan Creek area but no voucher specimens could be located. Field identification of cottontails was based on a ratio of ear length to hind foot length (Davis and Schmidly, 1994) and recognized five specimens as *S. audubonii*. Subsequent examination of skulls revealed the presence of only one representative of this species. This specimen's identity is further complicated by the fact that it is a subadult. The use of ear to hind foot length ratios did not consistently provide the correct identification of cottontails. Measurements from dried skins were more reliable than those from specimen tags; however, neither were infallible for correct identification of specimens.

Specimens examined (1): 1 mi. S, 1 mi. W Headquarters Building, Jose Maria Springs (29° 55.6' N, 100° 59.3' W), 1 (ASNHC 10791).

Lepus californicus texianus Waterhouse, 1848 (Black-tailed Jackrabbit): Jackrabbits were observed in all sampled areas of DRSNA and four specimens were collected. One specimen was collected from the Headquarters Building on 22 June 1998. A specimen from the primary sampling site Grassland Plateau was collected on 7 January 1999. One specimen was collected near Juniper Slope on 11 September 1999. On 19 November 1999 a specimen was collected from the ridge top near the radio towers. Other individuals were sighted in many areas of DRSNA.

Specimens examined (4): 1 mi. N, ¼ mi. E Headquarters Building, Juniper Slope (29° 57.3' N, 100° 57.9' W), 1 (ASNHC 11046); Headquarters Building (29° 56.4' N, 100° 58.3' W), 1 (ASNHC 11047); ¼ mi. S, 2½ mi. E Headquarters Building, 1 (ASNHC 11048); 1 1/3 mi. S, 1 mi. E Headquarters Building, Grassland Plateau (29° 55.2' N, 100° 57.1' W), 1 (ASNHC 11049).

INTRODUCED SPECIES

Eight species of non-native mammals representing two orders occur at DRSNA. The previous owners of the property intentionally introduced the seven representatives of the order Artiodactyla in the 1970s (J. Finegan, pers. comm.). The one representative of the order Rodentia is an accidental introduction resulting from human activity. There was no evidence of any other introduced species in the area, including feral cats and feral hogs.

ORDER ARTIODACTYLA
Family Cervidae

Dama dama (Linnaeus, 1758) (Fallow Deer): A native of southern Europe and the Mid-east, the fallow deer has been introduced into 93 Texas counties (Davis and Schmidly, 1994). Fallow deer were introduced into DRSNA in the mid-1970s in an effort to establish exotic game hunting (Scudday and Hanselka, 1975). According to Bill Armstrong (pers. comm.) these deer did not last long. The environment was too harsh for this species and there was not enough cover for them.

Axis axis (Erxleben, 1777) (Axis Deer): A native of India, the axis deer was introduced into Texas in the 1930s. Davis and Schmidly (1994) reported herds of this species in 94 counties in Texas, making it the most abundant exotic ungulate in Texas. There is a population of *A. axis* in East Canyon that was introduced in the 1970s (Scudday and Hanselka, 1975). This population consists of about 20 individuals and was sighted on a number of occasions. They probably spend most of their time at the mouths of Speed Canyon, East Canyon, and Escondido Canyon.

Cervus nippon Temminck, 1838 (Sika Deer): Originally from oriental countries such as China, Japan, Korea, and Manchuria, the sika deer has been introduced into 77 Texas counties (Davis and Schmidly, 1994). Sika deer have persisted at DRSNA since they were introduced in the mid-1970s (Scudday and Hanselka, 1975). No individuals were sighted during this study and Bill Armstrong has not seen any since 1996 (pers. comm.). This species most likely no longer occurs in the area with the possible exception of one or two stragglers.

Cervus elaphus Linnaeus, 1758 (Wapiti or Elk): The wapiti is native to Europe, Asia, and the Rockies of North America. They were introduced into the Trans-Pecos in 1928 and currently there are herds in five Trans-Pecos counties (Davis and Schmidly, 1994). Elk were introduced into DRSNA in the 1970s and persisted for almost 20 years. Bill Armstrong reports that the last of the elk population was extirpated in 1991 (pers. comm.).

Family Bovidae

Antilope cervicapra (Linnaeus, 1758) (Blackbuck): Blackbucks are native to Pakistan and India and were introduced into Texas in 1932 on the Edwards Plateau (Davis and Schmidly, 1994). They were introduced into DRSNA in the mid-1970s in an effort to establish exotic game hunting (Scudday and Hanselka, 1975). This species persisted until 1991 when the last of the DRSNA population was extirpated (Bill Armstrong, pers. comm.).

Ammotragus lervia (Pallas, 1777) (Barbary Sheep): The barbary sheep is endemic to North Africa but has been introduced into the Llano Estacado, Trans-Pecos, Edwards Plateau, and southern Texas (Davis and Schmidly, 1994). They were introduced to DRSNA at about the same time as the axis deer in the 1970s (Scudday and Hanselka, 1975) and still occur in the area near cliffs and in areas with high relief. A skull of *A. lervia* was collected from DRSNA and barbary sheep were sighted on the plateaus between canyons and near the top of steep slopes or cliffs. Like the white-tailed deer, hunting permits are issued for this species and make up a large portion of the income for the area. Bill Armstrong estimated that between 20 and 30 barbary sheep are harvested each year (pers. comm.).

Specimens examined (1): ¼ mi. S, 3 mi. E Headquarters Building (ASNHC 11167).

Ovis orientalis Linnaeus, 1758 (Mouflon): Mouflon are native to Turkey, the Middle Eastern countries, and the European islands of Corsica and Sardinia (Nowak, 1999). Scudday and Hanselka (1975) reported that mouflon were introduced in the 1970s to

stimulate hunting in the area. Bill Armstrong (pers. comm.) says that there was a relatively large population at DRSNA but he has not seen them for several years. Hunters killed two rams during the November 1999 hunt.

ORDER RODENTIA
Family Myocastoridae

Myocastor coypus (Molina, 1782) (Nutria): The nutria ranges throughout eastern, southern, and central Texas and reaches its western distributional limits in the Trans-Pecos, west-central, and north-central Texas. They were introduced to clean up overvegetated lakes and as a possible furbearer (Davis and Schmidly, 1994). No specimens of *M. coypus* were collected from DRSNA. One individual was sighted on the Devils River. Several people visiting DRSNA to fish reported hearing nutria along the banks in the evening. Scudday and Hanselka (1975) also reported this species occurring along the Devils River.

SPECIES OF UNVERIFIED OCCURRENCE

Nineteen species of mammals representing four orders have been recorded from Val Verde County, Texas but have not been recorded from DRSNA. Future research efforts might reveal the presence of these species at DRSNA.

Cryptotis parva (Say, 1823) (Least Shrew): The least shrew ranges throughout eastern and southern Texas and most of the Panhandle (Davis and Schmidly, 1994). It reaches its western distributional limits in west-central Texas (Simpson and Maxwell, 1989; Dowler and Boyd, 1996) and southwest Texas (Bailey, 1905) but does not occur on the Edwards Plateau (Goetze, 1998). This shrew prefers grassland habitats and might occur in the grassland areas between canyons; however, the lack of continuous suitable habitat from the nearest known record in Del Rio (Bailey, 1905) makes it unlikely that this species occurs in DRSNA.

Myotis yumanensis (H. Allen, 1864) (Yuma Myotis): The Yuma myotis occurs throughout the Rio Grande valley and Trans-Pecos as a migrant species. A single record from Starr County, Texas, justifies the extent of the range of this species into south Texas (Schmidly, 1991). This species is most commonly associated with watercourses and prefers lower elevations. In Texas it mostly has been collected near the Rio Grande (Schmidly, 1977) but the range of the species does include DRSNA. Scudday and Hanselka (1975) include this species as possibly occurring at DRSNA in their survey of the area. The cliffs along the Devils River provide ample roost sites for this species. The closest records of the Yuma myotis to DRSNA are from Del Rio and the mouth of the Pecos (Schmidly, 1991).

Pipistrellus subflavus (F. Cuvier, 1832) (Eastern Pipistrelle): Eastern pipistrelles range throughout eastern and southern Texas and reach the extent of their range in the Panhandle (Schmidly, 1991) and west-central regions of Texas (Dowler et al., 1992). This species has recently expanded its range into the Trans-Pecos (Yancey et al., 1995) and currently includes DRSNA. *Pipistrellus subflavus* most likely would occur near Dolan Springs where it has ample roost sites in the surrounding trees with thick growths of ball moss (*Tillandsia recurvirostra*), which is related to Spanish moss (*Tillandsia usneoides*), a preferred roost site for the eastern pipistrelle (Menzel et al., 1999). The closest records are from Del Rio and the Rio Grande River (Schmidly, 1991).

Lasiurus borealis (Muller, 1776) (Eastern Red Bat): The eastern red bat is a migratory species distributed across Texas (Schmidly, 1991). On the Edwards Plateau they are most commonly found in riparian and riverine areas (Goetze, 1998). Their range includes DRSNA and there are records for just north of Del Rio on the Devils River (Schmidly, 1991), and therefore it is likely that they are in the area. They would probably occur at Dolan Springs or Jose Maria Springs where there are large trees for roosting.

Plecotus townsendii Cooper, 1837 (Townsend's Big-eared Bat): Townsend's big-eared bat occurs

throughout the Trans-Pecos, Panhandle, and Edwards Plateau regions of Texas (Schmidly, 1991). In the Trans-Pecos it is most commonly found in rocky, canyon areas where there are plenty of crevices and caves for roosting (Schmidly, 1977). All of DRSNA is well within the range of this species and provides plenty of appropriate habitat, so it is reasonable to expect this species to occur there. The closest record of this species (TTU 6921) occurs just 3 mi. S, 12 mi. E of DRSNA between this area and Loma Alta (Schmidly, 1991).

Eumops perotis (Schinz, 1821) (Western Mastiff Bat): *Eumops perotis* ranges along the Rio Grande River in the Trans-Pecos and into Val Verde County. They prefer roost sites in rocky cliffs and canyons and need a large (>2 m) unobstructed drop from their roost site in order to take flight (Schmidly, 1991). The topography along Dolan Creek and the Devils River provides ample roost sites for this species. DRSNA is at the northern distributional limit of this species but does have suitable habitat. Scudday and Hanselka (1975) listed this rare species as possibly occurring in the area due to a record from Del Rio. This species has also been taken in Val Verde County from Langtry (Schmidly, 1991).

Canis latrans Say, 1823 (Coyote): This species has never been reported from DRSNA despite other records from Val Verde County. Bill Armstrong estimates that they are absent for about 20 miles (32 km) in any direction (pers. comm.). Boston (1966) reported that the coyote is not common in eastern Val Verde County due to extensive trapping by ranchers. The nearest record for this species is a specimen collected in 1905 near Del Rio (Bailey, 1905).

Mephitis macroura Lichtenstein, 1832 (Hooded Skunk): The hooded skunk occurs in the southern portion of the Trans-Pecos reaching its northern distributional limits in Ward County, Texas (Davis and Schmidly, 1994). This species most likely does not occur at DRSNA. Boston (1966) reported sighting a hooded skunk in the Edwards Plateau portion of northern Val Verde County, but no specimens have been recorded from the county. The nearest records for this species are over 100 miles (160 km) away in Pecos and Brewster counties (Schmidly, 1977).

Spermophilus spilosoma Bennett, 1833 (Spotted Ground Squirrel): The spotted ground squirrel occurs throughout the Panhandle and Trans-Pecos reaching its eastern distributional limits on the Edwards Plateau, Rolling Plains, and southern Texas (Davis and Schmidly, 1994). This species probably does not occur in DRSNA. Neither Boston (1966) nor Scudday and Hanselka (1975) listed this species as occurring in this area. Hall (1981) recorded a specimen from the mouth of the Pecos River.

Thomomys bottae (Eydoux and Gervais, 1836) (Botta's Pocket Gopher): Botta's pocket gopher ranges throughout the Trans-Pecos and reaches its eastern distributional limits on the Edwards Plateau (Davis and Schmidly, 1994). Scudday and Hanselka (1975) listed this species as possibly occurring at DRSNA but failure to find any sign of this species after a concentrated effort suggests that it may not occur here. Boston (1966) recorded this species from south of Loma Alta on Highway 277 and near Juno.

Chaetodipus hispidus (Baird, 1858) (Hispid Pocket Mouse): The hispid pocket mouse ranges throughout Texas with the exception of approximately eight counties in extreme eastern Texas (Davis and Schmidly, 1994). This species would most likely be encountered on the ridge tops between the many canyons at DRSNA. The closest records are from Del Rio and Comstock. Scudday and Hanselka (1975) and Boston (1966) did not list the hispid pocket mouse as occurring in the area.

Chaetodipus eremicus (Mearns, 1898) (Chihuahuan Desert Pocket Mouse): The Chihuahuan Desert pocket mouse ranges throughout the Trans-Pecos reaching its eastern distributional limits on the Edwards Plateau and Permian Basin (Davis and Schmidly, 1994). Lee et al. (1996) elevated the populations of *C. penicillatus eremicus*, the scientific designation of this species since 1900, in Texas to the specific level. The presence of this species at DRSNA is unlikely. Davis and Schmidly (1994) stated that the Chihuahuan Desert pocket mouse has not been encountered in rocky or gravelly soils. The streambeds of Dolan Creek and the Devils River are both composed of primarily boulders, rocks, and gravel. Boston (1966) and Scudday and Hanselka (1975) did not

include this species as occurring in the area. The two records of the Chihuahuan Desert pocket mouse for Val Verde County were collected from Del Rio and the Pecos River at the beginning of the century (Bailey, 1905).

Dipodomys merriami Mearns, 1890 (Merriam's Kangaroo Rat): Merriam's kangaroo rat ranges throughout the Trans-Pecos reaching its eastern distributional limits on the Edwards Plateau and Llano Estacado (Davis and Schmidly, 1994). This species most likely does not occur at DRSNA. Scudday and Hanselka (1975) did not list Merriam's kangaroo rat as a possibly occurring species, nor did Boston (1966) list this species as occurring east of the Pecos River in Val Verde County. The two records of this species for Val Verde County were collected in 1903 from Langtry (Bailey, 1905).

Neotoma micropus Baird, 1855 (Southern Plains Woodrat): The southern plains woodrat ranges throughout western, southern, and north-central Texas (Davis and Schmidly, 1994). Where *Neotoma micropus* and *N. albigula* are sympatric, this species is usually found in valleys between rocky slopes (Goetze, 1998). Habitat exists to support this species along Dolan Creek and in the canyon bottoms of East Canyon. The area at the mouths of East Canyon, Speed Canyon, and Escondido Canyon also would be suitable for this species. The closest records of this species are from near the Devils River in Amistad National Recreation Area (Ditton and Schmidly, 1977) and near Del Rio (Bailey, 1905; Boston, 1966).

Baiomys taylori (Thomas, 1887) (Northern Pygmy Mouse): The northern pygmy mouse ranges throughout Texas with the exception of the Trans-Pecos (Davis and Schmidly, 1994). This species would most likely be encountered around Dolan Springs. Both *Sigmodon hispidus* and *Reithrodontomys fulvescens* were collected at Dolan Springs and are often found in connection with *B. taylori* (Davis and Schmidly, 1994). The closest record for this species is from near Juno, about 15 miles (24 km) northwest of DRSNA (Goetze, 1998).

Onychomys leucogaster (Wied-Neuwied, 1841) (Northern Grasshopper Mouse): The northern grasshopper mouse ranges throughout western Texas reaching its eastern distributional limits in north-central Texas, southern Texas, and the Edwards Plateau (Davis and Schmidly, 1994). The probability of encountering this species at DRSNA is low, as its the preferred habitat of sandy soils or open brushland is either lacking or patchy in this part of Val Verde County. Scudday and Hanselka (1975) and Boston (1966) did not list this species as possibly occurring in the area. The nearest records are from Comstock in 1890 (Bailey, 1905).

Peromyscus eremicus (Baird, 1858) (Cactus Mouse): The cactus mouse ranges throughout the Trans-Pecos reaching its eastern distributional limits along the Pecos River and the lower Rio Grande valley (Davis and Schmidly, 1994). This species would most likely be encountered in DRSNA at the base of canyon walls or on cliff faces. Scudday and Hanselka (1975) did not list this species as occurring in the area. The records for Val Verde County are from the turn of the century near Comstock and Langtry (Bailey, 1905).

Mus musculus Linnaeus, 1758 (House Mouse): No specimens of this introduced species were collected at DRSNA. Scudday and Hanselka (1975) listed this species as occurring in the area but no voucher specimens could be located. The closest records of this species are from Del Rio (Boston, 1966).

Rattus rattus (Linnaeus, 1758) (Roof Rat): It is unlikely that black rats occur at DRSNA due to the paucity of human structures in the area. Scudday and Hanselka (1975) did not list this species as possibly occurring in the area. Boston (1966) recorded that this species was only found within the city limits of Del Rio.

COMMUNITY INTERACTIONS

Capture indices for bats were estimated using the number of bats captured divided by the number of net-hours that mist nets were operating (Table 1). Dolan Springs and a pool near Jose Maria Springs were the only two sampling sites used in this analysis. Fawcett Cave was excluded because mist nets or other constant effort methods were not used to sample this site.

The pool near Jose Maria Springs is located one mile south and one mile west of the Headquarters Building (29° 55.6' N, 100° 59.3' W). A total of 94 net-hours were sampled at this site. Three species were captured at this site: *Tadarida brasiliensis*, *Pipistrellus hesperus*, and *Antrozous pallidus* (Table 1). Both *T. brasiliensis* and *P. hesperus* were the most abundant bats at this site with a capture index of 0.032. *Antrozous pallidus* had a capture index of 0.021.

Dolan Springs was sampled for a total of 72.5 net-hours. Four species were captured at this site: *Tadarida brasiliensis*, *Myotis velifer*, *Lasiurus cinereus*, and *Lasiurus seminolus* (Table 1). *Tadarida brasiliensis* was the most abundant bat at this site with a capture index of 0.097, followed by *M. velifer*, *L. cinereus*, and *L. seminolus*.

The total capture indices for the year were estimated using 166.5 net-hours (Fig. 9). *Tadarida brasiliensis* is the most abundant bat species occurring at DRSNA with a capture index of 0.060. *Myotis velifer*, *P. hesperus*, and *L. cinereus* each have a capture index of 0.018. *Antrozous pallidus* and *L. seminolus* are fifth and sixth in abundance with capture indices of 0.012 and 0.006 respectively. With the inclusion of the bats at Fawcett Cave, the most abundant bat would be *M. velifer* due to the roosting colony located inside the cave.

A total of 197 captures were recorded for rodents from the five primary sampling sites at DRSNA. Total trap success for these sites was 4.9% out of 4000 trap nights. Capture indices were calculated for each species by primary sampling site for the year using 800 trap nights (Table 2).

Dolan Springs was the most diverse site within DRSNA with a total of six species of small rodents (Table 2). *Peromyscus leucopus* was the most abundant small rodent at this site with a capture index of 0.024 followed by *Chaetodipus nelsoni*, *Peromyscus pectoralis*, *Sigmodon hispidus*, *Peromyscus maniculatus*, and *Reithrodontomys fulvescens*.

Table 1. The capture indices for each species of bat from Dolan Springs, near Jose Maria Springs, and the total for both sites together. Bold-faced numbers represent the capture index for the most abundant species per sampling site and numbers in parentheses represent the total number of captures for that species per site.

	Dolan Springs	Jose Maria Springs	Total
Tadarida brasiliensis	**0.097 (7)**	**0.032 (3)**	**0.060 (10)**
Myotis velifer	0.041 (3)		0.018 (3)
Pipistrellus hesperus		**0.032 (3)**	0.018 (3)
Lasiurus cinereus	0.041 (3)		0.018 (3)
Antrozous pallidus		0.021 (2)	0.012 (2)
Lasiurus seminolus	0.014 (1)		0.006 (1)

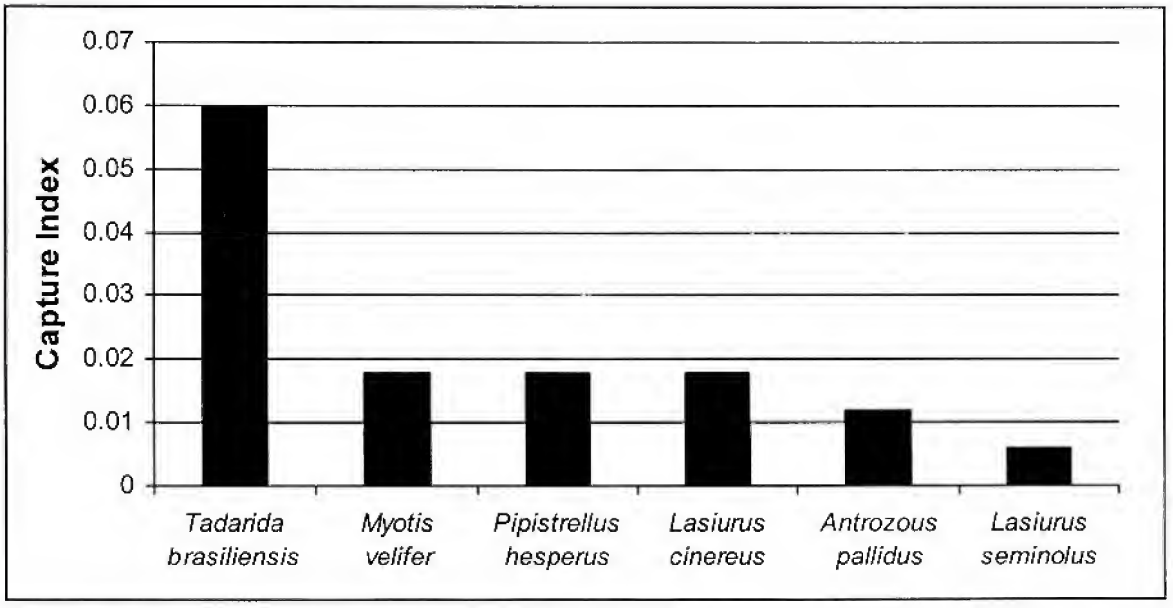

Figure 9. Graphic representation of the total capture indices for the bats at two sites in Devils River State Natural Area.

Cenizo Slope had a species composition of two species (Table 2): *P. pectoralis* (0.035) and *C. nelsoni* (0.016). Juniper Slope, which was similar in habitat to Cenizo Slope, also had these two species in similar abundances (Table 2) and a third species, *Perognathus merriami*. East Canyon, which had different vegetation and soil composition, had similar species abundances to these two slope sites (Table 2). *Peromyscus pectoralis* was again the most abundant with *C. nelsoni* ranking second.

Grassland Plateau differed from the other sites in that *C. nelsoni* did not occur there (Table 2). *Peromyscus pectoralis* was once again the most abundant small rodent with a capture index of 0.019 followed by *Perognathus merriami*. This site was the only site where *Reithrodontomys montanus* was captured.

The total capture indices for the year were calculated for each species using 4000 trap nights (Table 2). *Peromyscus pectoralis* was by far the most abundant small rodent at Devils River State Natural Area (Fig. 10), being encountered in every sampling site and having a capture index of 0.032. *Chaetodipus nelsoni* was the second most abundant small rodent, being collected at every site that had a slope while absent from sites without a slope. *Sigmodon hispidus* was abundant at Dolan Springs, but was not captured anywhere else in the park. This implies that the hispid cotton rat is locally abundant but likely not an important part of the rodent communities in other parts of DRSNA. *Perognathus merriami* probably has a greater abundance than evidenced at the five primary sampling sites. Several individuals were caught at other sites with loose soils, particularly in an area 2¼ miles north of the Headquarters Building (29° 58.4' N, 100° 58.2' W). *Peromyscus maniculatus, Reithrodontomys fulvescens,* and *R. montanus* each were captured only a few times at a single site.

Abundance of small rodents was also examined seasonally (Fig. 11). Capture indices were estimated using 1000 trap nights per season. Rodent capture diversity was greatest during the winter sampling period at DRSNA. Seven species were captured with *P. pectoralis* being the most abundant with a capture index of 0.0900, followed by *P. leucopus, S. hispidus, C. nelsoni, P. maniculatus, Perognathus merriami,* and *R. montanus*. The capture diversity for spring was five species. *Peromyscus pectoralis* was the most frequently captured rodent during this period with a capture index of 0.0230, followed by *C. nelsoni, P. leucopus, S. hispidus,* and *Perognathus merriami.* Only *C. nelsoni* and *S. hispidus* were captured more frequently in spring. *Peromyscus maniculatus* and *R. montanus* were not captured during this period.

Table 2. The capture indices for each species of small rodent from the primary sampling sites at DRSNA. Bold-faced numbers represent the capture index for the most abundant species per sampling site and the number in parentheses represents the total number of captures for that species at that site.

	Dolan Springs	Cenizo Slope	Juniper Slope	East Canyon	Grassland Plateau	Total
Peromyscus pectoralis	0.013 (10)	**0.035 (28)**	**0.031 (25)**	**0.060 (48)**	**0.019 (15)**	**0.032 (126)**
Chaetodipus nelsoni	0.014 (11)	0.016 (13)	0.010 (8)	0.025 (2)	—	0.009 (34)
Peromyscus leucopus	**0.024 (19)**	—	—	—	—	0.005 (19)
Sigmodon hispidus	0.010 (8)	—	—	—	—	0.002 (8)
Perognathus merriami	—	—	0.001 (1)	—	0.005 (4)	0.005 (5)
Peromyscus maniculatus	0.004 (3)	—	—	—	—	<0.001 (3)
Reithrodontomys fulvescens	0.001 (1)	—	—	—	—	<0.001 (1)
Reithrodontomys montanus	—	—	—	—	0.001 (1)	<0.001 (1)

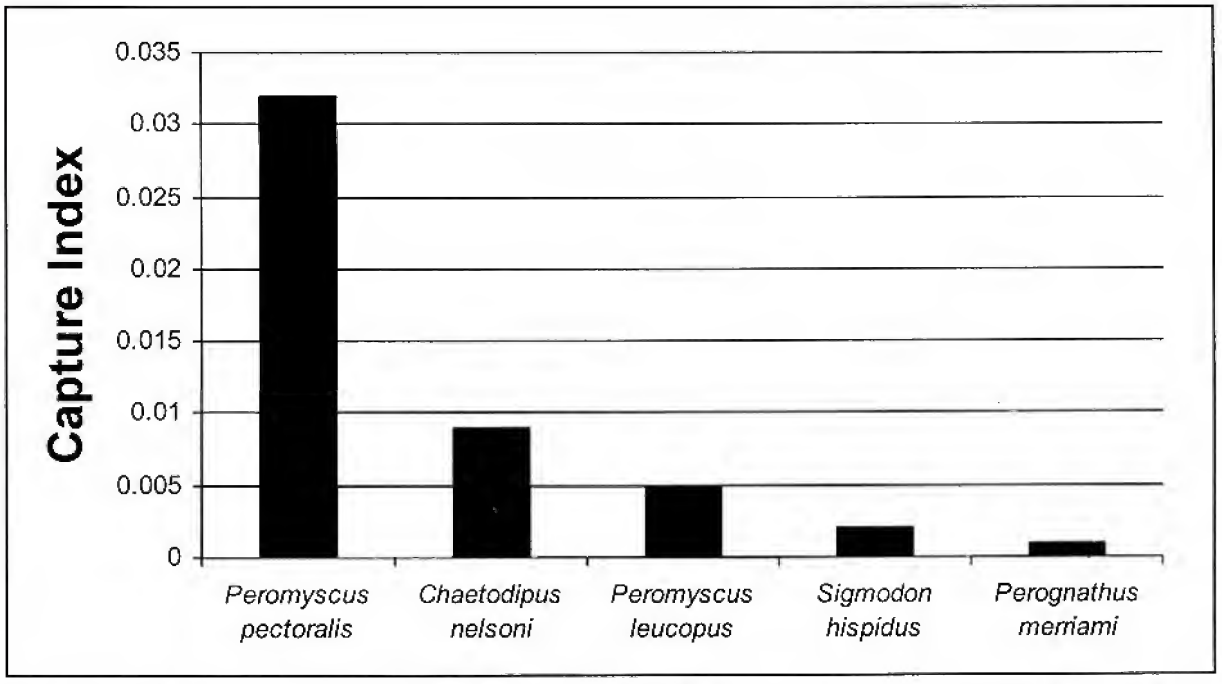

Figure 10. Graphic representation of the total capture indices for the five most abundant rodents in Devils River State Natural Area.

Capture diversity during summer was the lowest of any season with only four species captured (Fig. 11). *Chaetodipus nelson* (0.0090) was the most abundant rodent followed by *P. leucopus*, *Perognathus merriami*, and *Peromyscus pectoralis* with lower capture frequencies. *Sigmodon hispidus* was not captured in summer. Capture diversity for autumn was six species with *P. pectoralis* (0.0120) again being the most abundant rodent. *Peromyscus leucopus, C. nelsoni, S. hispidus, P. maniculatus*, and *R. fulvescens* were captured less frequently.

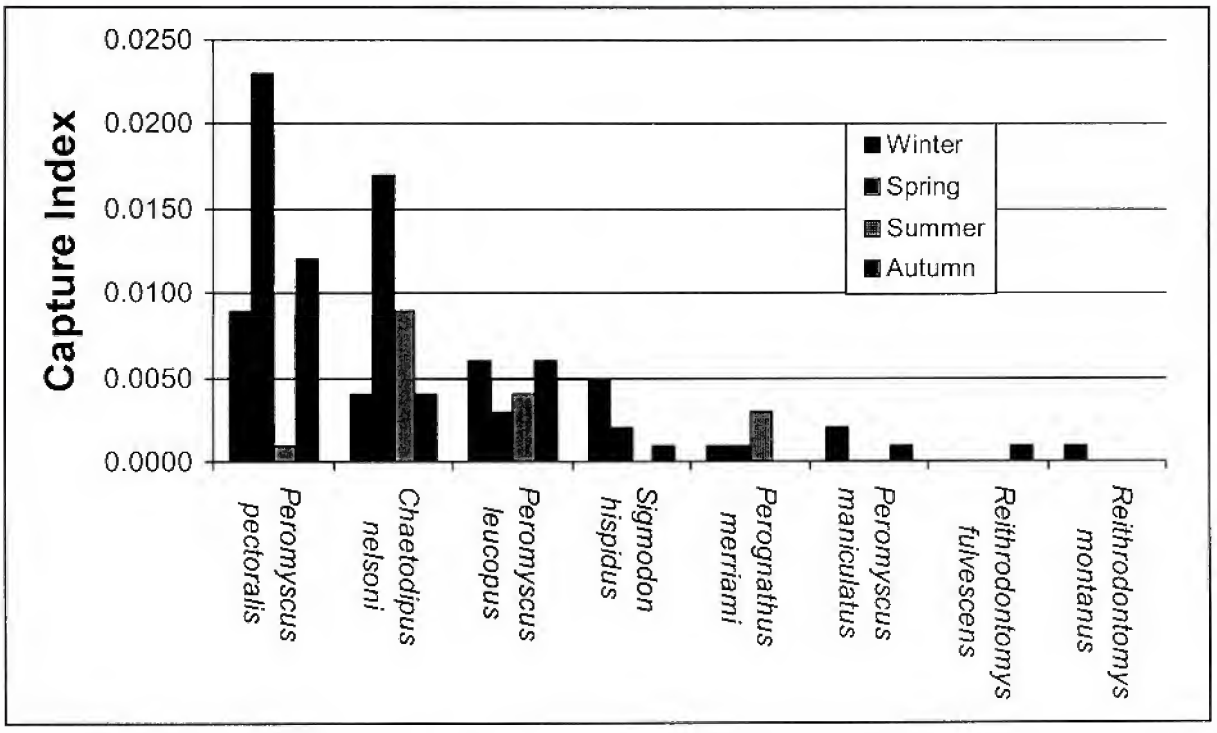

Figure 11. Graphic representation of the seasonal capture indices for small rodents at Devils River State Natural Area.

Each primary sampling site was analyzed using a 50m transect to determine the percent composition of each of the environmental variables. Juniper Slope was characterized by a high influence of herbaceous vegetation and cobblestone substrates (Table 3). East Canyon had a high percentage of succulent vegetation and boulder sized substrates, while Cenizo Slope was more influenced by woody vegetation and cobblestone (Table 3). Grassland Plateau was characterized by a high percentage of herbaceous vegetation and soil (Table 3). A high percentage of bedrock with approximately equal percentages of woody and herbaceous vegetation characterized Dolan Springs (Table 3).

Brant (2000) performed a canonical correspondence analysis (CCA) using all environmental variables to describe the habitat associations among rodents at DRSNA. When Monte Carlo permutation tests were performed to test the significance using all environmental variables, the results were insignificant. An ordination diagram and discussion of the results are presented in Brant (2000). Using only vegetation variables and capture indices, a CCA was performed producing three axes that explained 100 percent of the variation. The first axis is defined by percent succulent vegetation (Table 4), whereas the second axis is defined by percent woody vegetation. The first two axes explain 94.2 percent of the variation. The third axis is defined by percent herbaceous vegetation and explains the remaining 5.8 percent of the variation (Table 5).

An ordination diagram (Fig. 12) shows a graphic representation of habitat associations based on vegetation variables. Sites are represented by dots and species are represented by triangles. Vegetation variables are represented as arrows with the length of the arrow representing the importance of that variable. The closer a species is to the origin, the more generalized that species is, according to the vegetation variables sampled. The same is true for sample sites. The smaller the degree of the angle between a vegetation vector and a species or sampling site, the more that vector influences the species or site.

Table 3. The environmental variable percentages for each sampling site.

	Juniper Slope	Cenizo Slope	East Canyon	Grassland Plateau	Dolan Springs
% Woody	0.5671	0.6191	0.4088	0.0384	0.4032
% Herbaceous	0.7466	0.4404	0.4345	0.9616	0.4092
% Succulent	0.2208	0.2904	0.5228	0.1108	0.0360
% Soil	0.0160	0.0327	—	0.9604	0.1828
% Gravel	0.3373	0.1864	—	0.6304	0.0224
% Cobblestone	0.6035	0.6951	0.0055	0.0424	—
% Boulder	0.0511	0.0611	0.8745	0.0280	0.0644
% Bedrock	0.0217	0.0049	0.1200	—	0.5532
% Slope	0.1830	0.2267	0.3300	—	—

Table 4. The vegetation variable canonical coefficient component loadings for each canonical axis. The values in bold face represent high component loadings for that canonical axis.

Axis	*1*	*2*	*3*
% Woody	0.0084	**-0.9370**	0.2816
% Herbaceous	-0.4566	0.6875	**0.4591**
% Succulent	**-0.7915**	-0.4211	-0.4346

Table 5. A summary of the canonical correspondence analysis using only vegetation variables with eigenvalues, percentage of variation explained, and correlation coefficients listed for each canonical axis.

Axis	1	2	3	4	Total Inertia
Eigenvalues	0.540	0.185	0.045	0.058	0.828
Species-environment correlations	0.969	0.995	0.838	0.000	
Cumulative percentage values					
of species data	65.2	87.6	93.0	100.0	
of species-environment relation	70.1	94.2	100.0	0.000	
Sum of all unconstrained eigenvalues					0.828
Sum of all canonical eigenvalues					0.770

A Monte Carlo permutation test was performed to analyze the significance of the habitat associations predicted by the vegetation variables. The first axis alone was not significant (F= 1.871, P= 0.2000). However, all the axes together were significant (F= 4.420, P= 0.0350). Habitat associations between species and sampling site thus can be differentiated using the vegetation variables sampled.

DISCUSSION

Fieldwork, museum surveys, and literature searches have recorded the presence of 47 species of mammals occurring in the immediate vicinity of DRSNA for the last 30 years. Eight of the 47 species were introduced into the area within the last 50 years. These species represent eight orders, comprised of one didelphimorph, one xenarthran, one insectivore, seven chiropterans, nine carnivores, nine artiodactyls, 16 rodents, and three lagomorphs. Another 19 species possibly occur in the area, including one insectivore, five chiropterans, two carnivores, and 11 rodents.

The mammal fauna at DRSNA is similar to that of other regions in this part of Texas. Schmidly (1977) reported 96 species of mammals occurring in the Trans-Pecos region of Texas. Thirty-four of those species reported for the Trans-Pecos occur at DRSNA. Goetze (1998) listed 76 species of mammals occurring on the Edwards Plateau of which 38 occur at DRSNA. The only species occurring at DRSNA that was not listed by Goetze (1998) was *Lasiurus seminolus*. The mammalian fauna of DRSNA seems to have a closer affinity with that of the Edwards Plateau biotic province, with which it shares 37 species, compared with the Trans-Pecos biotic province, with which it shares 33 species.

The mammals occurring at DRSNA are comparable to other sites within Val Verde County, Texas. Boston (1966) listed 39 species of mammals as occurring east of the Pecos River in Val Verde County. Thirty-one of the species occurring at DRSNA were listed by Boston (1966). Scudday and Hanselka (1975) reported 29 species as occurring in the Dolan Falls area. Twenty-eight of the species they listed were verified by this study. The exception is *Mus musculus*, which was listed by Scudday and Hanselka (1975) but was never encountered from June 1998 through November 1999.

The rodent diversity and density at most sites within DRSNA were low during this study, with a total capture success of only 4.9 percent. The drought affecting the area during this study might have resulted in reduced rodent populations.

Three species of rodents, two bats, and one carnivore were each represented by only one specimen. The three county records for Val Verde County resulting from this project are included in these six specimens along with *Reithrodontomys fulvescens*, which has not been collected in this county for over one hundred years.

The environmental variable that had the most influence on species composition of rodents in grassland habitat types at DRSNA was the percent soil present (Brant, 2000). Of the three rodent species that occur in this habitat type in DRSNA, one is a habitat generalist (*Peromyscus pectoralis*) and one is only found at this site (*Reithrodontomys montanus*). Only *Perognathus merriami* demonstrates the influence of this environmental variable on habitat association. *Perognathus merriami* was found in two habitat types but is more associated with the grassland habitat due to the presence of soil, and to a lesser degree herbaceous vegetation and gravel (Fig. 12). Another site located 2¼ miles north of the Headquarters Building was also sampled with some regularity and was similar to the Grassland Plateau primary sampling site. A high number of *P. merriami* were encountered at this site, thus supporting the habitat association described by the CCA.

The three slope sampling sites represent three habitat types that are similar in many respects and were plotted in the same quadrant of the ordination diagram (Fig. 12). The most important environmental variable for these habitats appears to be succulent vegetation. Woody vegetation could also be considered important,

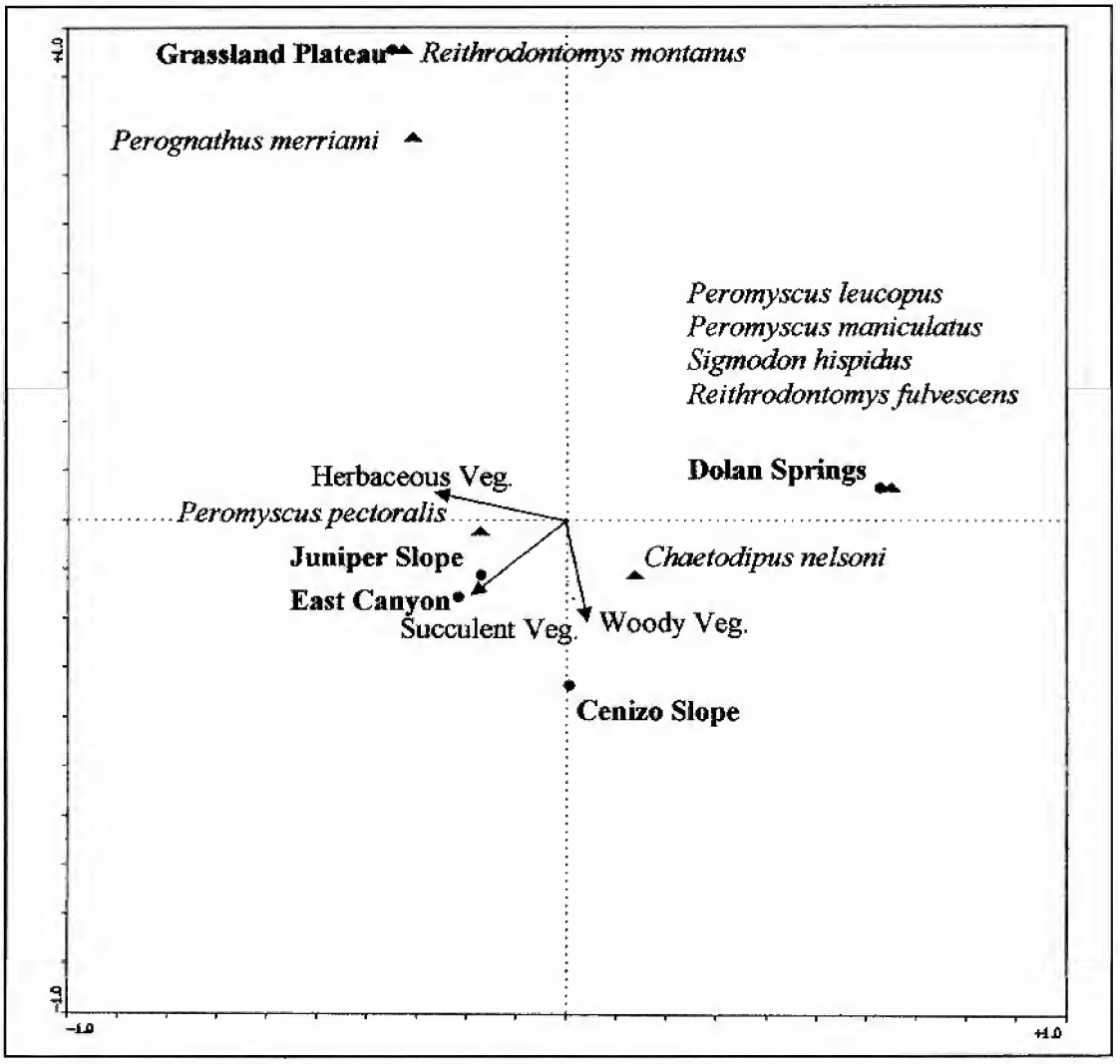

Figure 12. Ordination diagram of a canonical correspondence analysis describing habitat associations of small rodents at Devils River State Natural Area using capture indices for 8 species of small rodents and vegetation variables for 5 sites. Species are represented by triangles (▲) and primary sampling sites are represented by dots (●). Arrows represent the vectors of the environmental variables. The longer the arrow is, the more important the variable. The closer to the origin a species is, the more generalized that species is according to the environmental variables sampled. The smaller the degree of the angle between an environmental vector and a species or sampling site, the more that vector influences the species or site.

especially for the Cenizo Slope primary sampling site. The species occurring in these habitats, *Peromyscus pectoralis* and *Chaetodipus nelsoni*, are habitat generalists and represent the two most abundant rodents in DRSNA. These two species are encountered in every habitat type with one exception; *C. nelsoni* is not found in grassland habitats and is positioned in the opposite quadrant from this habitat type on the ordination diagram (Fig. 12).

The most influential environmental variable for rodents in the riparian habitat at Dolan Springs was the presence of bedrock (Brant, 2000). For this study four species are described as riparian inhabitants

(*Peromyscus leucopus*, *Sigmodon hispidus*, *Peromyscus maniculatus*, and *Reithrodontomys fulvescens*). The other two species occurring in this habitat type are the two habitat generalists found in other sites (*Peromyscus pectoralis* and *Chaetodipus nelsoni*). *Peromyscus pectoralis* has its lowest abundance at this site and is positioned in the opposite quadrant from the riparian habitat on the ordination diagram. These species were most often encountered on or at the base of the slope distal to the spring, rather than in the vegetation immediately adjacent to the spring.

Of the eight species of small rodents sampled at five primary sampling sites, the six murid species showed seasonal abundance peaks in the cooler portions of the year. The two heteromyid rodents, *Chaetodipus nelsoni* and *Perognathus merriami*, showed seasonal abundance peaks in the warmer portions of the year. *Peromyscus pectoralis* is more likely to be encountered in autumn or spring than in the summer. *Chaetodipus nelsoni* is more likely to be encountered in the spring or summer than the fall or winter and *Perognathus merriami* is more likely to be captured in the summer than at any other time of year.

Reproductive activity seems to be related to seasonal abundance for two of the four above rodent species. *Chaetodipus nelsoni*, which is more abundant in the spring and summer, is reproductively active in the spring and summer with scrotal males occurring from January to June and pregnant females encountered in June and July. *Peromyscus pectoralis* is less abundant in summer than at any other time of year and is reproductively active from late autumn to early spring with pregnant females encountered from January to March and scrotal males encountered from October to March.

Peromyscus leucopus seems to be a year-round breeder with reproductive males and females encountered in January, August, and November during this study. *Sigmodon hispidus* has a seasonal abundance peak in the winter but is reproductively active in the summer. Two reproductive individuals (a male and a female) were found in August. We collected another female with placental scars in May. Cameron and Spencer (1981) reported a year-round breeding season for *Sigmodon hispidus*, as did Lackey et al. (1985) for *Peromyscus leucopus*.

The zoogeographic affinities of DRSNA are typical of the Edwards Plateau. Goetze (1998) recognized seven faunal elements for the mammals of the Edwards Plateau. Based on his results the mammalian fauna at DRSNA can be divided into five faunal elements: Chihuahuan, Widespread, Neotropical, Eastern, and Campestrian.

The Chihuahuan faunal element contains species with distributions centered in the Mexican states of Chihuahua, Coahuila, and Durango. Seventeen of the species occurring at DRSNA are included in this faunal element: *Notiosorex crawfordi, Myotis velifer, Pipistrellus hesperus, Antrozous pallidus, Lepus californicus, Ammospermophilus interpres, Spermophilus mexicanus, Spermophilus variegatus, Perognathus merriami, Chaetodipus nelsoni, Reithrodontomys fulvescens, Peromyscus pectoralis, Neotoma albigula, Bassariscus astutus, Spilogale gracilis, Conepatus mesoleucus*, and *Sylvilagus audubonii*. Two of these species, *Ammospermophilus interpres* and *Chaetodipus nelsoni*, reach their eastern distributional limits in or near Val Verde County. Almost half (44 percent) of the faunal composition at DRSNA originates from the Chihuahuan faunal element. Goetze (1998) found that 36 percent of the Edwards Plateau species originated from the Chihuahuan faunal element.

The Widespread faunal element is comprised of those species with large enough distributions that it is difficult to assign them to any of the other faunal elements. Twelve species occurring at DRSNA are designated as part of the Widespread faunal element. These species include: *Lasiurus cinereus, Castor canadensis, Peromyscus leucopus, Peromyscus maniculatus, Erethizon dorsatum, Urocyon cinereoargenteus, Procyon lotor, Taxidea taxus, Mephitis mephitis, Puma concolor, Lynx rufus*, and *Odocoileus virginianus*. Thirty-one percent of the species occurring at DRSNA are accounted for by the Widespread faunal element as compared to the 26 percent of species accounted for on the Edwards Plateau (Goetze, 1998).

The Neotropical faunal element is comprised of species with distributions centered in southern Mexico and Central America. Five species at DRSNA are included in the Neotropical faunal element: *Didelphis virginiana, Tadarida brasiliensis, Dasypus*

novemcinctus, Sigmodon hispidus, and *Pecari tajacu.* Goetze (1998) determined that this faunal element accounts for 11 percent of the species occurring on the Edwards Plateau. The Neotropical faunal element was responsible for 13 percent of the species at DRSNA.

Species with distributions centered in the eastern United States comprise the Eastern faunal element. Three species from this faunal element occurring at DRSNA are at their western distributional limits and can only be found in riparian habitats such as Dolan Springs or Jose Maria Springs. This faunal element includes the following four species: *Lasiurus seminolus, Nycticeius humeralis, Sciurus niger,* and *Sylvilagus floridanus.* The Eastern faunal element accounts for 10 percent of the species occurring at DRSNA, whereas it accounts for 11 percent of the Edwards Plateau fauna (Goetze, 1998).

The Campestrian faunal element contains species with distributions centered on the Great Plains of North America. The only species occurring at DRSNA that is included in this faunal element is *Reithrodontomys montanus*, which reaches its southern distributional limits in this area of Texas and can only be found in grassland habitats. Three percent of the mammals occurring at DRSNA originate from the Campestrian faunal element. Nine percent of the mammals on the Edwards Plateau originate from the Campestrian faunal element (Goetze, 1998).

The mammalian fauna at DRSNA is composed primarily of western Edwards Plateau mammals, which include many Chihuahuan species. The area is near the western distributional limits of three eastern species, the eastern distributional limits of two western species, and the southern distributional limits of one northern species. The two most abundant rodents are *Peromyscus pectoralis* and *Chaetodipus nelsoni*, both Chihuahuan in origin, and the most abundant bat, *Tadarida brasiliensis*, is a Neotropical species. The larger mammals are mostly comprised of Widespread species.

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Addresses of authors:

JOEL G. BRANT

Department of Biology
Angelo State University
San Angelo, TX 76909
e-mail: jbrant@ttacs.ttu.edu

Current address:
Department of Biological Sciences
Texas Tech University
Lubbock, TX 79409-3131

ROBERT C. DOWLER

Department of Biology
Angelo State University
San Angelo, TX 76909
e-mail: robert.dowler@angelo.edu

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It was through the efforts of Horn Professor J Knox Jones, as director of Academic Publications, that Texas Tech University initiated several publications series including the Occasional Papers of the Museum. This and future editions in the series are a memorial to his dedication to excellence in academic publications. Professor Jones enjoyed editing scientific publications and served the scientific community as an editor for the Journal of Mammalogy, Evolution, The Texas Journal of Science, Occasional Papers of the Museum, and Special Publications of the Museum. It is with special fondness that we remember Dr. J Knox Jones.

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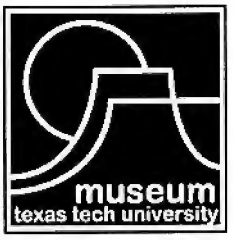

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